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EVALUATION OF A RESIDUE MANAGEMENT WHEEL FOR HOE-TYPE NO-TILL DRILLS

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Background

Adoption of reduced tillage systems in the agricultural regions of the Pacific Northwest (PNW) lags behind that of the United States as a whole. The slow adoption of this practice in the PNW is due not only to economic and agronomic concerns, but also to the lack of trouble-free, reliable seeding equipment for planting into the heavy residue encountered in this region. Commercial shank- and disc-type no-till drills were developed primarily for low residue conditions and for crops planted in wide rows. In heavy residue or when row spacing is narrow, shank-type drills are prone to plugging, causing operator frustration and reducing field capacity. Shank drills also tend to cause large piles of residue to form, which cover the crop row and suppress young seedlings. Another problem with shank drills is that soil can sometimes be thrown out of the seed furrow and onto the adjacent seed row. This adversely affects seeding depth and seedling emergence. Disc-type drills are prone to "hair-pinning" straw into the seed furrow rather than placing seed into moist soil with good seed to soil contact. In an effort to overcome these problems, a project was initiated to develop a residue management attachment that would improve no-till drill performance.

Objectives

The objectives of this study were to:

1. Develop a seeder attachment that would allow a hoe-type no-till drill to handle large amounts of residue and improve drill performance.
2. Evaluate the performance of the seeder attachment in terms of stand count and yield.

Residue Management Wheel

The prototype device developed (patent pending) (Fig. 1) consists of a fingered rubber wheel, a rubber inner ring, and a spring-loaded arm that pivots about vertical and horizontal axes. The unit is designed to attach to the tool bar of hoe-type no-till drills and positioned so that the inner ring is approximately one-half inch away from the furrow opening shank. When seeding, the ground-driven rubber-fingered wheel and inner ring hold down and "walk" through crop residue, preventing it from building up on the shank and seed tube. They also help control soil disturbed by the furrow opener so that more soil stays within the seed row.

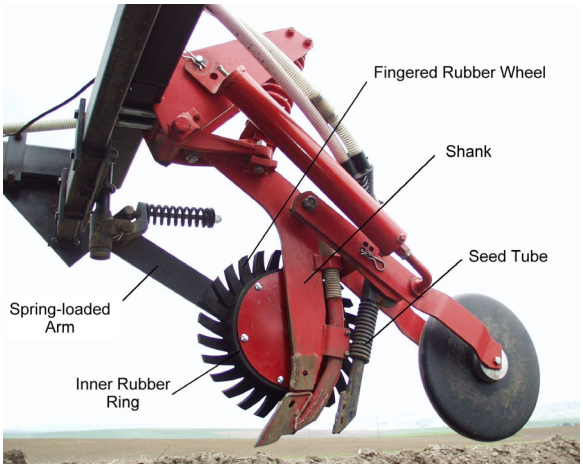

Figure 1. Residue management wheel assembly.

When clumps of crop residue build up between the wheel and the shank, the arm holding the wheel is able to rotate away from the shank, causing the pile of crop residue to dislodge. After swinging out, the wheel will naturally track back into its operating position, close to the shank. Other features of the design are that the wheel has adjustable, spring-loaded down pressure and vertical height adjustment.

Methods

The seeder attachment was evaluated in the fall of 1999 and spring of 2000 at various locations in northeastern Oregon. Test site locations varied significantly in the amount and condition of crop residue and were planted to a variety of different crops including yellow mustard, winter Canola, winter wheat, spring wheat, spring barley, and lupin (Table 1). Three types of combines were used to harvest the plots prior to sowing: a stripper combine, a rotary combine, and a cylinder-type combine. Some of the combines were equipped with chaff spreaders, some with chaff spreaders and straw choppers, and some with neither (Table 1). In some experiments the residue was left standing, while in other experiments the residue was either flailed or rotary mowed (Table 1). Amounts of residue present at the time of seeding ranged from a low of approximately 1,600 lb/acre to a high of almost 9,000 lb/acre, while stubble height ranged from less than 2 in to slightly greater than 24 in. All plots were seeded with a 12-ft-wide, 12-in-row spacing, hoe-type no-till plot drill manufactured by Conserva-Pak™ Seeding Systems[1] of Indian Head, Saskatchewan, Canada. To evaluate the performance of the residue wheel, one side of the drill (six openers) was equipped with the residue management wheel, the opposite side (six openers) without.

Depending on location, plot length varied from a minimum of 40 ft to a maximum of 200 ft. All experiments were a randomized complete block design with four replications except for the winter wheat experiment at Pendleton, Oregon, where the experimental design was a split-plot design with two replications. After the seedlings had emerged and the date of the last killing frost had past, stand counts in each plot were taken using the following procedure. First, a random sampling location, at least 15 ft from either end of the plot, was selected for each replication. The number of plants within 1.64 ft of either side of the sampling location were then counted and recorded for the inner 4 rows of each 6-row plot. The outer two rows of each plot were not counted to avoid edge effects. Yield was determined by harvesting 5 rows from each plot with a plot combine.

Results

Depending on residue treatment, the residue management wheel was found to increase seedling stand count of winter Canola by 44-53 percent, spring barley by 24 percent, mustard by 41 percent, lupin by 8.7 percent, spring wheat by 15-16 percent, and winter wheat by 17-20 percent as compared to the standard drill (Table 1). These differences were statistically significant at the levels indicated in Table 1. Use of the residue management wheel also increased the yield of winter Canola by 8-11 percent, spring barley by 3 percent, mustard by 5 percent, lupin by 8 percent, spring wheat by 1-6 percent, and winter wheat by up to 8 percent (Table 1). Although

[1] Reference to a product or company is for specific information only and does not endorse or recommend that product or company to the exclusion of others that may be suitable.

Table 1. Site description, seedling stand count and yield results of 1999-2000 residue management wheel evaluation studies in Oregon.

Crop	Location	Combine type	Residue management	Residue	Stubble height	Residue mngt. wheel	Sowing rate	Stand count	Percent increase in stand	Yield	Percent increase in yield
				lb/acre	in		seeds/ft^2	plants/ft^2		lb/acre (bu/acre)	
Fall Canola	Pendleton	Stripper	Flail	4500	<2	No	38.7	9.6 ***	52.7	536	7.7
						Yes		14.5		577	
Fall Canola	Pendleton	Stripper	Standing	4500	19.0	No	38.7	11.3 ***	43.7	582	11.1
						Yes		16.2		647	
Spring barley	Moro	Cylinder	Chaff Spreader	3229	11.4	No	32.7	12.6 **	24.0	2360 **	3.4
						Yes		15.7		2440	
Mustard	Helix	Rotary	No Chaff Spreader	1611	7.5	No	15.9	3.9 ***	41.0	1232 ***	5.0
						Yes		5.5		1294	
Lupin	Adams	Rotary	Chaff Spreader	3909	8.3	No	6.1	3.8 *	8.7	763 **	8.4
						Yes		4.2		827	
Spring wheat	Adams	Stripper	Standing	8758	24.3	No	26.4	12.6 *	14.7	(58.1) *	6.0
						Yes		14.4		(61.6)	
Spring wheat	Adams	Cylinder	Straw Chopper Chaff Spreader	8758	8.5	No	26.4	12.4 *	16.2	(65.8)	0.9
						Yes		14.4		(66.4)	
Winter wheat	Pendleton	Cylinder	Flail	5944	<2	No	24.6	19.8 ***	17.2	(100.1)	-11.9
						Yes		23.2		(88.2)	
Winter wheat	Pendleton	Cylinder	Rotary Mow	5944	<2	No	24.6	19.8 ***	19.5	(82.6)	7.8
						Yes		23.6		(89.0)	

*, **, *** Means between use and non-use of residue management wheels in the same residue treatment row and column are significantly different by the LSD test at the P = 0.10, .05, and 0.001 levels, respectively.

increased yields were observed in all but one trial, these differences were not always statistically significant (Table 1).

Conclusions

This study showed that for small seeded crops, such as mustard and winter Canola, use of the residue management wheel increased stand counts by more that 40 percent. Approximately 15 percent of this increase was estimated to be due to the observed fewer piles of residue and clods covering the seed row. The remaining 25 percent could not be explained and further study is warranted. The study also showed that for large seeded crops, such as wheat and barley, use of the residue management wheel increased stand counts by approximately 17 percent. In trials where residue density was greater than 5,000 lb/acre, increased stand counts were observed to be due to fewer piles of residue covering the seed row. Similar increases in

stand count were seen in trials where residue densities were lower than 5,000 lb/acre; however there were no dramatic differences between treatments in seedbed condition and a reason for this increase could not be formulated. Although large differences in stand counts were seen in the mustard and winter Canola crops, adequate plant stands were present due to high seeding rates. Consequently, yield differences were not statistically significant, or they were less than 5 percent higher. Yield increases of up to 8 percent were seen with the larger seeded crops, but these differences were not always statistically significant. The results of this study indicate that the residue management wheel improves stand counts and yield in all levels of residue for direct seed systems. Further testing and analysis is needed to determine if the device is economically justifiable. Further study is also warranted to determine the cause of the increased stand and yield performance in low residue conditions.